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MINISTRY OF AVIATION

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AN ACCOUNT OF E.R.D.E.

PREPARED FOR THE OCCASION

OF

CHIEF SCIENTIST'S CONFERENCE

(SECOND DAY)

24 JUNE 1960

EXPLOSIVES RESEARCH AND
DEVELOPMENT ESTABLISHMENT,
WALTHAM ABBEY,
ESSEX.

RESTRICTED

C O N T E N T S

ORGANISATION

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Dr. G.H.S. Young (D.C.S.O.)

Superintendents of Branches (S.P.S.O.)

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Propellants 2	Mr. P.R. Freeman	P.2
Explosives 1	Dr. A.L. Lovecy	E.1
Explosives 2	Mr. E.G. Whitbread	E.2
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S.P.S.O.	Dr. A.W.H. Pryde
	Mr. G.W.C. Taylor
	Dr. N. Uri
	Mr. H. Ziebland

NOTE: This booklet was prepared originally before the extensive reorganisation of E.R.D.E. in 1963, which resulted in a redistribution of work (largely unchanged) between new divisions. An attempt has been made to follow the change by some crude surgery to the booklet!

FOREWORD

1. E.R.D.E. is an integrated establishment concerned with conventional explosives, the latter term embracing high explosives (for shell), propellants (for rockets, guns, turbine starters, etc.) and many types of intrinsically unstable subtances used in initiators (e.g. lead azide), primers, delay compositions and so forth.

2. The business of E.R.D.E. is research and initial development, carried out on behalf of all three Service Departments. Service 'projects' per se are not the establishment's responsibility, its contributions to them being made indirectly, e.g. through R.P.E. in the case of rocket propellants, A.R.D.E. in respect of gun propellants, rifle powders, initiator compounds, adhesives and sealing compounds for ammunition, etc., etc., and the Royal Ordnance Factories.

3. The existing 'White Paper' strength, mainly chemists, is about 60 Scientific Officer grades, 100 Experimental Officer grades, and 7 Engineers. No Service Officers are attached. The industrial strength is approximately 600.

4. A noteworthy feature of the military explosives field is the absence of an industrial network. Only one firm in Britain engages in it, the Nobel Division of Imperial Chemical Industries Ltd., as a side line of their business in commercial explosives.

5. Apart from new explosive compositions for specific purposes, the important end-products emanating from E.R.D.E., are basic data and systematized information whereby the senior staff are enabled to exercise their advisory and directing functions. In these they are also assisted by the possession of a variety of 'testing' facilities capable of operation on a significant scale.

C.H. Johnson

DIRECTOR

May, 1960

PROPELLANTS 2.

The Branch is concerned with research and development of plastic propellant. In the case of plastic propellant, the main effort is now on development, and a pilot plant with a maximum output of about 2 tons per week is operated on South Site. The plant is used for investigation of methods of processing and to supply experimental compositions to R.P.E. and A.R.D.E. for rocket motor experimentation; current production averages about three quarters of a ton per week. In addition basic research is being carried out on the combustion of propellants. Combustion research is concerned with unravelling the complex reactions which occur in the decomposition and burning of propellants, particularly those containing aluminium metal; with the chemical behaviour of flames at low pressures, and theoretical work on the relationship between burning velocity in liquids and solids and rates of chemical reaction. Another section on North Site is responsible for the development of mechanical tests of solid propellants of all types, and is making a study of properties under high rates of strain and of general rheological problems. An instrumented set of rolls is available for laboratory investigation of the rheology of new cordites. Equipment for measurement of basic data such as density, thermal conductivity and specific heats is used as needed.

Finally, another section is carrying out basic studies of heat transfer problems, for example to boiling liquids, and measurements of the thermal conductivity of fluids over wide ranges of temperature and pressure. These latter have included oxygen, nitrogen, argon, toluene, kerosine, ammonia, and, at the request of U.K.A.E.A., 'heavy water' and certain organic moderators used in nuclear reactors.

EXPLOSIVES 2.

The activities of the branch cover research on detonation phenomena, the mechanism of the initiation of explosion (usually referred to as "sensitiveness") and to the production of novel types of propellant and explosives based on polyurethanes. Equipment includes small processing facilities (laboratory scale) for composite type solid propellants, provided some years ago for research purposes, and these are at present devoted to the preliminary examination of these polyurethane compositions.

Research on detonation and sensitiveness is chiefly applied to the mechanism of initiation of solid explosives, by shock wave and by fragment attack, and the transformation of burning into detonation in solids. Basic research is also carried out on the sensitiveness of initiator compounds to impact, friction and, in particular, electrostatic discharges. Much has been done during the last few years to elucidate the character of such discharges and its bearing on observed phenomena.

Propellants 1. - Continued from next page.

Pilot scale facilities for the production of polyurethane propellant have been installed, capable of filling rocket motors of up to 500 lbs. wt. These are in two separate buildings, one of which is fully air-conditioned to enable work to be undertaken, if required, on ingredients sensitive to moisture.

In addition there is available a ballistic assessment service which involves the development of methods as well as the carrying out of ballistic measurements on propellants, such as by static firing of small rocket motors, determination of burning rate in strands of propellant, and the so-called 'vented' and 'closed vessel' methods; and the obtaining of calorimetric data.

PROPELLANTS RESEARCH III

The work of this Branch is entirely concerned with the so-called 'colloidal' propellants typified by cordite. It has many ramifications. The usual requirement is for a new composition having stated ballistics and storage life, and it is P.R.III's responsibility to carry the matter to the stage of factory production. The facilities available at E.R.D.E. cover manufacture, in full sized equipment, of single-base (nitrocellulose) and double base (nitrocellulose and nitroglycerine) propellants, by solvent, solventless, and casting methods, for all weapons, including small arms, guns, mortars and rockets. Quantities of cordite up to about one ton may be manufactured in 'grains' of various sizes and shapes (large or small) to assist weapons development by the design establishments. Advice is offered to the production factories on processing problems, and, when necessary, experiments are conducted to help resolve difficulties. Assistance is given to the Inspection authorities in the preparation of specifications for propellant ingredients, and the setting up of acceptance standards for radiographic and ultrasonic methods of test. The Branch is also responsible for the detailed technical control of extra-mural contracts on Cast Double Base (C.D.B.), one of the propellant candidates for rocket charges in excess of 15 ins. diameter.

At present, effort is devoted to the standardisation of selected rocket compositions of merit, the development of casting powders required for making C.D.B. and to increasing the specific impulse obtainable from the latter. For various reasons, the property of adhering to the wall of the motor casing is valuable in a rocket propellant. This presents a problem of some difficulty in C.D.B. and solutions to it are being sought.

ANALYTICAL SERVICES

This Branch has a number of distinct functions as follows:

1. It develops new analytical methods for all experimental compositions which subsequently form the basis for specification and factory control tests. It also provides an analytical service for the whole establishment and assists other branches in specialised analytical applications which may arise in their research.

2. It advises on all aspects of stability and surveillance testing of propellants. This work ranges from climatic trials to studies of new ways in which the intrinsic stabilities of new compositions may be evaluated.

3. It is responsible for deciding questions of compatibility of propellants, high explosives, and initiators with materials in which they may come in contact, and carries out the considerable volume of testing and advisory work which this entails.

4. It develops new instrumental techniques which are likely to find applications in the explosives field. Development work is going on, for example, on gas chromatography, thermal analysis, infrared spectroscopy and X-ray crystallography. Fundamental research is carried on in these last two fields. and also in nuclear magnetic resonance and mass spectrometry.

5. Radiochemistry, with particular emphasis on the thermal degradation of specifically labelled polymers.

EXPLOSIVES AND INTERMEDIATES

The making of the individual ingredients from which propellants and other explosive compositions are formulated involves both chemistry and chemical engineering, and this Branch is responsible for studying the chemistry. Investigations are made to maintain or improve the supply of raw materials and intermediates used, one example being the selection of suitable woodpulps for paper from which nitrocellulose is produced. (This illustrates what is meant by the title "intermediates").

Research into the chemistry of existing methods of manufacture, and into possible alternative ways of synthesising compounds already known to be useful, forms a substantial part of the work of the Branch. This provides a fund of basic information on chemical efficiencies, reaction kinetics and mechanism, by-product formation, etc., for use in the related chemical engineering work, and in advisory services to the Royal Ordnance Factories on their development programmes, and on problems arising in current production. This knowledge also proves useful in a assessing the advantages and drawbacks of novel substances which attract attention from time to time, and in making suitable amounts of them for purposes of evaluation.

In the special case of initiatory explosives, the Branch has a section which, in addition to research on the preparation and properties of these peculiarly touchy compounds, is responsible for developing processes of manufacture to the full scale (requirements are measured in pounds, not tons) for adoption by the Filling Factories. In this work, and in establishing the requisite characteristics of materials to suit the needs of filling and functioning, close collaboration is maintained with the appropriate branches of A.R.D.E.

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At the present time, the major subjects of research are the storage stability of High Test Peroxide, the preparation and reactivity of alkylated boranes, and the effect of conditions of recrystallisation upon certain explosive properties of R.D.X., the most powerful conventional high explosive of World War II. Various activities of mainly technological interest connected with R.D.X./T.N.T. production, and the manufacture and filling of initiators, etc., are also in hand.

CHEMICAL ENGINEERING

The Chemical Engineering Branch is concerned with the development of processes and plant in the manufacture of high explosives, and some propellants, and of their intermediates and ingredients. It undertakes experimental manufacture of miscellaneous chemicals as a service to other groups, and engages in underlying chemical engineering research as far as its small resources in staff will permit.

As examples of this work in the recent past, new processes for manufacturing picrite (an ingredient of cordite) were developed on a 50 to 100 lb/hr pilot plant scale, and were adopted for new plants at R.O.F. Bishopton and in America. A high explosive of exceptional power, H.M.X., was manufactured on a pilot plant for the first time in this country, involving also the invention of a new recovery process for the acetic acid in the spent nitrating acid. The explosive was supplied for an essential requirement, and the pilot plant gave information for plants built subsequently at R.O.F. Bridgwater. More recently a new continuous process of T.N.T. manufacture has been perfected on a 4 lb/hr pilot scale. With the present interest and priority on solid propellants, work is turning more to propellant ingredients, such as ammonium perchlorate, polyesters and isocyanates. Processes for their manufacture in the quality required for propellants are under investigation and they are being produced in large and small experimental quantities. New types of plant for both continuous and discontinuous mixing and casting of polyurethane propellants are being studied in collaboration with S.P.R.I.

As one example of miscellaneous chemicals manufacture, a few tons of a special cross-linking polyester are being made and supplied to Aldermaston.

/Underlying

Underlying this development work, the Branch is pursuing research on crystallisation as a unit operation; control of crystal size and habit in manufacture being a factor of importance in controlling the burning rate of certain solid propellants.

Another section is carrying our basic studies of heat transfer problems, for example to boiling liquids, and measurements of the thermal conductivity of fluids over wide ranges of temperature and pressure. These latter have included oxygen, nitrogen, argon, toluene, kerosine, ammonia, and, at the request of U.K.A.E.A., 'heavy water' and certain organic moderators used in nuclear reactors.

MATERIALS RESEARCH 1.

The research activities of this Branch are directed towards obtaining a better understanding of the behaviour of non-metallic materials, plastics, rubbers, adhesives, and fibrous substances, in order to promote their successful application in Service equipments and weapons.

With the rapidly growing use of these 'high polymer' materials by structural engineers, often under conditions of severity, much basic experimental work and theoretical investigation is called for since the constituent molecules are complex to a degree unparalleled in the case of metals, and many of their properties are time dependent. There is much to be studied at extremes of temperature, at very fast rates of mechanical stressing e.g. shock loading, and, on the opposite tack, the influence of mechanical loads applied over long periods of time. It is also necessary to examine the effects of the environment when this is in any way exceptional.

The Materials Laboratory undertakes work on problems arising in connection with ammunition and conventional weapons. The crying need, however, is for basic research since an unknown degree of risk is accepted with plastics as structural materials, the present state of ignorance of their intimate molecular configurations being comparable to the position existing in metallurgy half a century ago.

Synthetic chemical work on new polymers, because it is being pursued elsewhere, has only been engaged upon sufficiently to give one or two members of the Laboratory the necessary acquaintance with this important field.

/Investigations

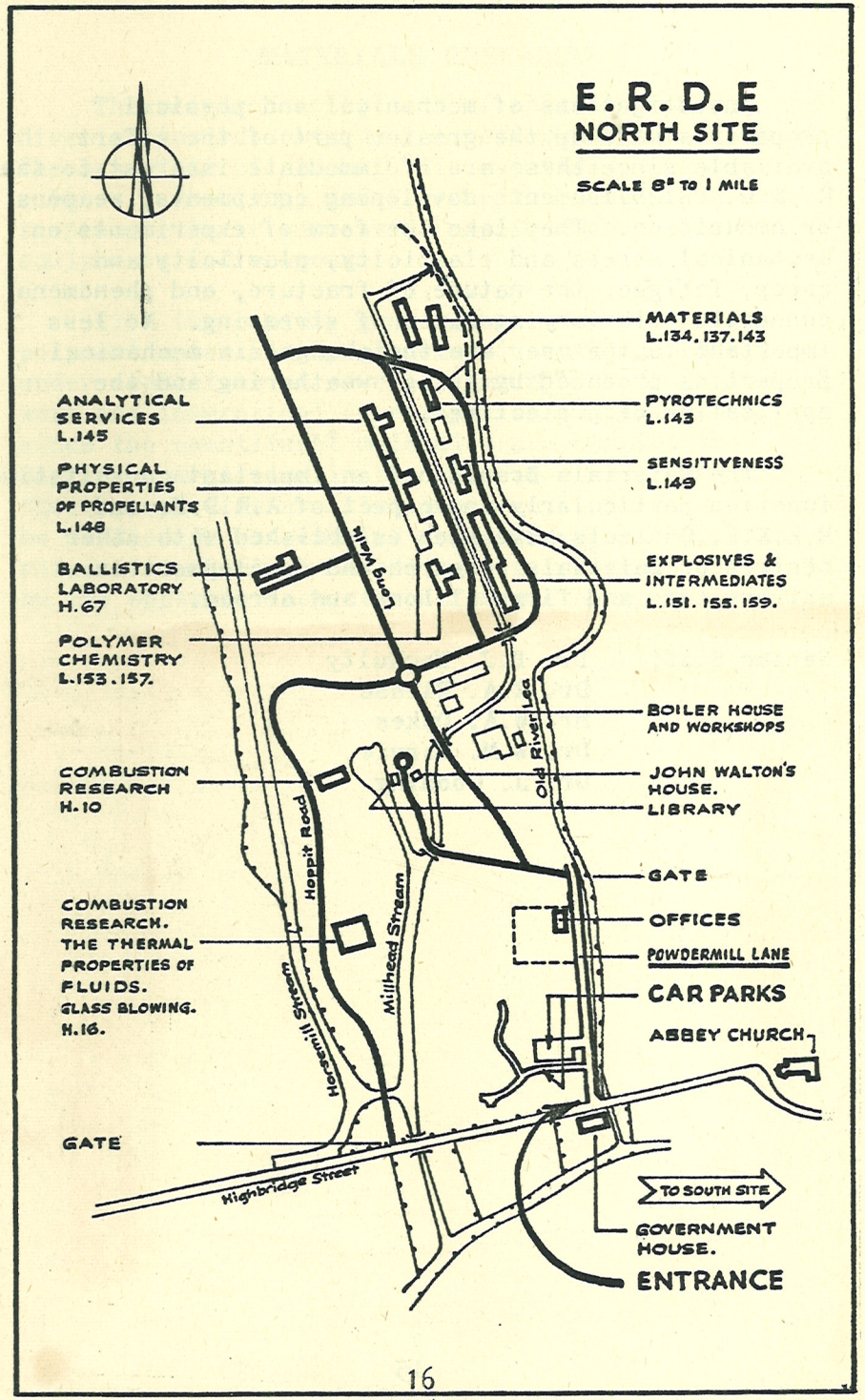
Investigations of mechanical and physical properties make up the greater part of the effort available since these are of immediate interest to the R. & D. establishments developing equipments, weapons or ammunition. They take the form of experiments on mechanical stress and elasticity, plasticity and creep, fatigue, the nature of fracture, and phenomena connected with varying rates of stressing. No less important to the user are the changes in mechanical properties produced by aging, weathering and the application of protectives.

The Materials Branch has an important consultative function particularly in respect of A.R.D.E. and M.E.X.E. Contacts have been established with other centres of materials research and development in universities and firms at home and abroad.

M.2.

MATERIALS RESEARCH

This is a new branch investigating the development of new materials principally inorganic. Work is going on with the production of "whiskers" of silicon nitride and similar refractories and also on the production of crystals by direct deposition from the vapour phase.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Long Walk
Hoppit Road
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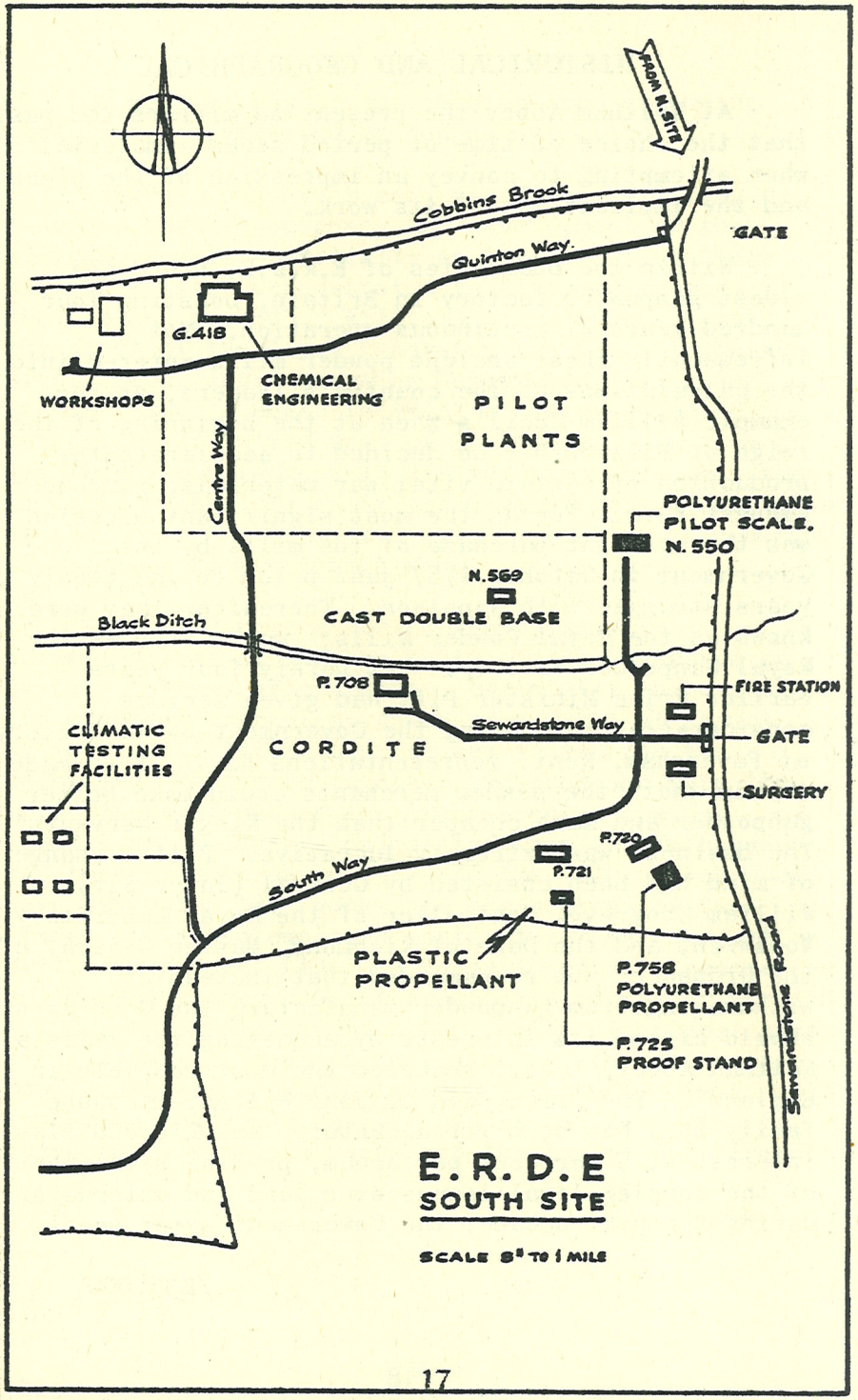
FROM N. SITE
Cobbins Brook
GATE
Quinton Way.
G.418
WORKSHOPS
CHEMICAL
ENGINEERING
PILOT
PLANTS
Centre Way
POLYURETHANE
PILOT SCALE.
N. 550
N.569
CAST DOUBLE BASE
Black Ditch
P.708
FIRE STATION
Sewardstone Way
GATE
CLIMATIC
TESTING
FACILITIES
CORDITE
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P.720
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PROPELLANT
P.725
PROOF STAND
Sewardstone Road
E.R.D.E
SOUTH SITE
SCALE 8" TO 1 MILE

HISTORICAL AND GEOGRAPHICAL

At Waltham Abbey the present so mirrors the past that the choice of time or period seems immaterial when attempting to convey an impression of the place and the implications of its work.

Within the boundaries of E.R.D.E. stood the oldest gunpowder factory in Britain, boasting four hundred years of continuous operation. Not infrequently these ancient powder mills entered into the calculations of the country's leaders, as for example William Cecil's when at the beginning of the reign of Elizabeth I he decided to accelerate the production of certain vital war materials, gunpowder amongst them. For us the most significant occasion was the outright purchase of the mills by the Government in October 1787 just prior to the twenty years struggle with Napoleon. Thereafter they were known as the Royal Powder Mills; much later as the Royal Gunpowder Factory. Yet barely four years earlier Prime Minister Pitt had given serious consideration to closing the Government-owned factory at Faversham, Kent, representations having been made to him that "the powder merchants could make better gunpowder and much cheaper than the King's servants". The business was extremely lucrative. Pitt's change of mind had been assisted by General (later Sir) William Congreve, Controller of the Royal Laboratory, Woolwich, and the Duke of Richmond, Master General of the Ordnance, who recommended that instead of withdrawing from gunpowder manufacture the Government should extend its interests by acquiring the mills at Waltham Abbey, "..... reckoned the most complete in England". The price paid to John Walton, in whose family they had been for a century, was £10,000 plus interest at 5 per cent per annum, pending settlement of the complex legal issues over land and waterways. During the next decade, the Government spent nearly

/£35,000

£35,000 more on buying surrounding land extending their water rights and on new construction.

General Congreve's son, also named William, is renowned for his advocacy and development of the military rocket - initially an instrument of flame warfare - first demonstrated to Pitt and members of the Cabinet in 1805. William Congreve Jnr. joined the staff of the Royal Laboratory in 1791 at the age of nineteen, later becoming Deputy Controller and, on his father's death in 1814, succeeding to the baronetcy and to the post of Controller. In view of all these coincidences it is understandable that the part the father played in the Government's acquisition of the powder mills should have come to be attributed mistakenly, to his famous son.

William Congreve Jnr. began systematic investigations at Waltham Abbey and at Faversham on quality control of gunpowder, especially in respect of the charcoal ingredient which gave a lot of trouble. By 1810, in a little over twenty years, the two Government factories together had produced more than 18,000 tons of powder and 'recovered' a further 6,000 tons. Congreve calculated that the Exchequer had thereby been saved £341,448 17s. 3¾d. which would have otherwise have gone into the pockets of the trade. In a contemporary mortar trial carried out on Marlborough Downs (the Lea Valley Growers' Association would have approved) Waltham Abbey's gunpowder carried 4,430 yards, Faversham's 4,340, while, it almost goes without saying, samples submitted by six merchants, poor wretches, ranged between 3,800 and 4,270 yards. Whatever Congreve's qualifications may have been in accountancy - he was member of Parliament for Plymouth

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from 1818 until his death in 1828 and wrote pamphlets on improving the currency - the King's servants, under his direction, certainly appear to have justified themselves.

The first Storekeeper at Waltham Abbey was a remarkable character named James Wright. (A sergeant of that name was enrolled in the original Rocket Brigade whose first action was the battle of Leipzig in 1813). As Storekeeper, at a salary of £150 per annum, he seems to have combined the duties of Superintendent, Administrative Officer, Chief Clerk and Assistant (Sci.). He submitted technical progress reports in the form of letters to his superior officers. "Sir, I beg to inform you of the result of this day's trial .... Sir, I have the honour to transmit a Sketch for laying the pipes from the Gasometer for conveying the Hydrogen gas ... also is enclosed an Estimate of the expense for converting such means (as) we have by us to adapt the same to your Suggestion, as called for by the Board under date 16th ult ...." A collaborator of Wm. Congreve Jnr. and Wright was Major By, the ill-fated founder of By Town, renamed Ottawa, Canada's capital city.

The descendants of James Wright served the Royal Gunpowder Factory throughout the 19th and into the 20th century. A grandson, Henry, packed off to Canada, restored his reputation and gained his return passage by quick thinking and bold action in persuading the General commanding the Quebec garrison (luckily for Henry the aide-de-camp was a native of Waltham Abbey too) to retract an ill-considered order to blow up the magazines when these were threatened by a spreading fire in the locality, and instead to get the troops to dig protective earthworks. As the magazines contained several hundred tons of powder

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the city was undoubtedly saved from disaster. Another grandson, James, emigrated to Mooresburg, Tennessee, United States of America, and it has recently come to light (from information supplied by a previous Director of E.R.D.E., exiled, albeit meritoriously, in that far-off land) that the design of the Confederate Powder Works at Augusta, Georgia, owed, by chance, a great deal to inspiration from Waltham Abbey. Long after the Civil War was over, Colonel (General) George Rains, late of the Confederate Army wrote:-

> "But one man - Wright - could be found in the Southern States who had seen gunpowder made by an incorporating mill, the only kind that can make it of the first quality; he had been a workman at the Waltham Abbey Government Gunpowder Works in England ..... I was much indebted to his knowledge and experience ..... I (also) came into possession of an invaluable pamphlet by Major Bradley the Superintendent of the Waltham Abbey Works; in this the entire process and machinery employed at that Factory - the best existing in any country - was succinctly stated; Drawings, or working plans, or details of the buildings, or apparatus, however, were not given."

On a small point of detail, Major Bradley was never Superintendent of the Works. The story is reminiscent of what happened in the first and second World Wars in which, notwithstanding the quantities of explosives manufactured, it could be asserted that Waltham Abbey's contribution in chief was expertise, in the persons of numerous staff and foremen who left to help the new Ordnance Factories get going in Britain and the Commonwealth, and in America.

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From history to riverine, or brookish, geography. The Horsemill Stream which defines the western boundary of North Site, is a reminder of the earliest means of turning the stone wheels of the incorporating mills which mixed the solid ingredients of gunpowder. Horses were not finally dispensed with until well into the next century, but about 1730 Bourchier Walton, father of John (?), taking advantage of the fall of the land, constructed an artificial high level canal with mills spaced out along its banks, the water spilling over paddle wheels into the tail streams a few feet below on either side. This "new scheme" seemed to be threatened by contemporary Government action aimed at increasing London's water supply, but in the end the Act "for ascertaining, preserving and improving the navigation of the River Lea ....." which passed the Lords in 1739 left sufficient water for Bourchier to work his mills.

With the expansion of the factory under Government control, water again became an issue early in the next century when additional rights were acquired over the Lea extending from Nazeing to the Black Ditch (the latter is marked on the map of South Site). During the same period mills were built along Lower Island, south of Highbridge Street, which with its canal and the Lea forms a tenuous link between our North and South Sites. Unhappily a succession of serious explosions, the last occurring on April 13th, 1843, by which seven operatives died, caused their abandonment. Steam power arrived in the mid-fifties and with it comparatively modern looking press-houses for gunpowder, one of which was recently demolished to make way for new electricians' workshops on North Site. Rather surprisingly, a few of the old mills at the northern end of Walton's canal were converted to steam

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in the first World War. Nemesis overtook all of them in the second when a land mine from a German bomber dropped on Hoppit during the winter of 1940-41. From that moment gunpowder manufacture at Waltham Abbey virtually ceased. Following the extensive flooding of North Site in the Spring of 1947 it was decided to empty the 'high level' canal by diverting it into the Horsemill Stream, dredging and widening the latter and regulating the flow of water by a weir. Visitors to the Combustion laboratories who stand on the bridge (not too many at once) connecting Hoppit with the Information building and Library - in ancient times John Walton's sulphur mill and mixing house respectively - can view the old sluice gates which once held back the high level water, and the now quiescent pool that carried away the over-spill along the Millhead Stream. The process of disengagement from the past was completed this April, 1960, when the skeletons of the old mills were demolished, their cement and brick foundations sold for hardcore and the area bulldozed. By June 24th it may have been grassed over.

John Walton's old house (it has been added to) and pillared sundial in front stand on the far side of the Library from Hoppit bridge. It is occupied by the Editorial and Reports section.

When Ministry of Supply came on the scene in 1945 metalled roads were non-existent apart from the approach to the main gate along Powdermill Lane which is as ancient as the factory itself. The network of canals and narrow gauge railways with their hand-trundled covered wagons had served instead. Access to many of the magazines was by water. Barges carrying cargoes of cordite were towed by horses down the Lea

/as

as far as the lock at Bromley-by-Bow, at which point they hoist sail for Woolwich. The "Lady of the Lea" made her last voyage from Waltham Abbey on May 20th, 1946. The present road circuits were not completed until 1957, twelve years after the takeover.

A reporter who had been on a conducted tour of the Royal Gunpowder Factory in the summer of 1898 wrote an account of it in the Strand Magazine. The following is an extract:-

> "..... we walked miles; we plunged into thickets, crossing innumerable streams and occasionally gliding from one building to another in a swift electric launch, the panting of whose screw scared the birds and rabbits that abound in this extraordinary place."

The launch referred to had been designed by Major-General W.H. Noble, R.A., Superintendent from 1885 until his death in 1892. Swiftness is not reckoned a virtue in an explosive establishment; powered by Grove cells "The Spark" could make six knots, the batteries serving also to light up water-side buildings as the General went his rounds. The launch, alas, like the rabbits which used to be had at the back door of the Superintendent's house for a shilling, have passed into history. But the extreme tip of North Site - a magazine area - up along the Cornmill Stream by Newton's Pool to Fishers Green is an extraordinary place still, and despite occasional loud bangs from the Sensitiveness Section on New Hill, innumerable birds and waterfowl find refuge there; pheasant and duck, heron and kingfisher are often to be seen.

/Since

Since 1945, the plan has been, as far as practicable, to concentrate research on North Site and development activities on South Site. The individual buildings which compose the two prominent ranges flanking the eastern boundary of North Site were put up, some in early some in late Victorian times, for gunpowder manufacture. The later ones - dates on the towers span the years 1877 to 1889 - may also have been used for smokeless powders (guncotton, i.e. nitrocellulose) the art of producing which in acceptably stable condition having been mastered by that time. During the nineties most were converted to cordite manufacture. Today, with the single exception of half one of the early Victorian buildings at the southern end of the western range, they have all been transformed into research laboratories. And very satisfactorily too. (Map on page 16).

Quinton Hill Farm, purchased in 1886 to accommodate the first cordite factory in Great Britain, forms the bulk of South Site. In addition to the incorporating and press houses, drying stoves and other cordite processing buildings, provision had to be made for the manufacture of guncotton, nitroglycerine and nitric acid, and for recovering spent acids. The new R. & D. establishment inherited a vast slum, vestiges of which are to be seen in the Chemical Engineering area, slowly being tidied up, however, by demolitions and conversions. The new facilities on South Site for solid propellant development are a different kettle of fish, several buildings for special purposes having been constructed and many old ones converted to new uses. This is a major asset and in some respects unique.

The spirit of scientific enquiry and invention has been a feature of Waltham Abbey since 1787, with

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ups and downs of course. The history of explosives technology abounds in the names of men who worked here. The Honourable Board of Ordnance were accustomed to consult members of the Royal Society on technical matters of difficulty (William Congreve Jnr. was elected Fellow in 1812) and close ties with the academic world have persisted to this day. Having regard to the fog in which chemistry was enveloped early in the nineteenth century - Dalton's "New System of Chemical Philosophy" was first published in 1808 - it is remarkable to find Storekeeper Wright expressing his results on charcoal "distillation" with complete lucidity. In 1801 a committee of the Royal Society visited the Royal Powder Mills to report on the possibility of electrostatic hazards arising from rolling wooden barrels on leather covered floors and from the use of silken screens for sifting powders. Michael Faraday headed another investigating board after the fatal explosion on Lower Island in 1843. The latest thoughts and observations on electrostatic discharges and other hazards will be presented to some of the visitors attending Chief Scientist's Conference.

The Strand Magazine's reporter, quoted earlier, confessed on leaving to being somewhat "oppressed by the tremendous energy lying dormant in every building". Presuming this remark to have been directed at nitroglycerine, and not back-handedly at the staff, today's visitors will like to know that steps have been taken to shield them from this kind of oppression. But dangers do exist and they should be especially careful how they step off the pavement in Highbridge Street.

M E M O R A N D A

MEMORANDA